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N-PHOSPHORYL AMINO ACIDS AS SMALL CHEMICAL MODELS FOR STUDY OF THE GENETIC CODE ORIGIN

Abstract

The genetic codes are nearly universal in life. There are three main concepts on origin and evolution of the genetic codes, such as the stereochemical theory,the coevolution theory,and the error minimization theory, all of which are compatible with the frozen accident hypothesis. However, the origin of genetic code is still a mysterious question. N-Phosphoryl amino acids with many novel chemical and biological properties could be considered as small molecular chemical models of co-evolution of proteins and nucleic acids for the origins of life (Zhou, et al. 1996; Zhao and Cao, 1994; Zhao and Cao, 1999; Gao, et al. 2011). Furthermore, it is found that N-phosphoryl amino acids could be formed by treatment of amino acids with inorganic phosphates derived from the volcanic activities or meteorolites in aqueous solution under mild reaction conditions. In our previous work, we found that N-(O, O-diisopropyl)phosphoryl threonine could react with uridine to form peptides and oligonucleotides in anhydrous pyridine or in water. Therefore, it is proposed that the reaction of N-phosphoryl amino acids with nucleosides could be regarded as a co-evolution model to study many processes of life origin, such as genetic code origin and chiral origin. In this work, the reactions of N-phosphoryl amino acids (Contained old amino acids) and four nucleosides such as A, G, C, and U in aqueous solution were investigated by UPLC-HRMS and 31P NMR. It was found that the yields of dinucleotides formed by the reaction depended on specific N-phosphoryl amino acids and nucleosides. For the reactions of N-(O, O-diisopropyl) phosphoryl phenylalanine,the yields of dipeptide Phe-Phe could be significantly improved through the addition of catalytic adenosine. However, the addition of uridine would inhibit the formation of Phe-Phe dipeptide. The genetic and anti-genetic codes for Phe are UUX and AAX respectively. It is very interesting to find that there may be some relations between the N-phosphoryl amino acids and nucleotides. Currently, the interactions between twenty N-phosphoryl amino acids and four nucleotides are extensively and systematically investigated in order to elucidate the intrinsic mechanisms. The results may provide some new sights for understanding the origin and chemical evolution of genetic code in the prebiotic process.

References Zhou W. H., et al. (1996). Origins Life Evol. Biosphere, 26: 547. Zhao Y. F., et al. (1994). J. Biol. Phys., 20: 283. Zhao Y. F., et al.(1999). Pure Appl. Chem., 71: 1163. Gao, X., et al.(2011)Eur. J. Org. Chem., 17: 3220.